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ABSTRACT

This key to freshwater and anadromous fishes of California is included as the fifth of a series of guides being produced by Project MER (Marine Ecology Research). This project is part of the effort to improve environmental education in the San Francisco Bay Area schools by gathering and organizing data on the ecological character of the San Francisco Bay-Delta-Estuary Complex. Related documents are SE 016 645--SE 016 648 and SE 016 650. (JP)

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SPECIES OF TECHNIQUES
and
GUIDES FOR THE STUDY
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SAN FRANCISCO BAY-DELTA-ESTUARY COMPLEX
PART 4

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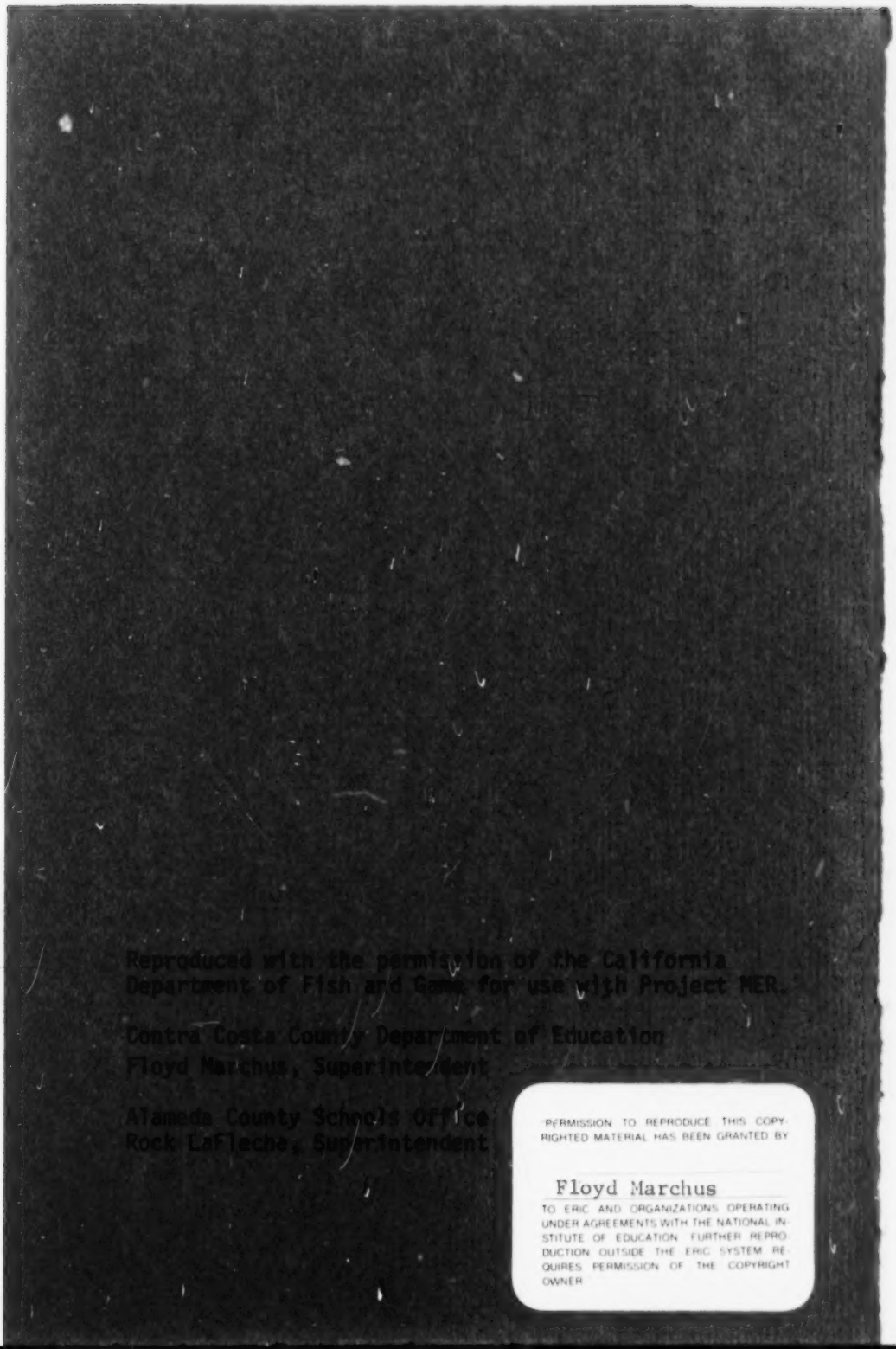

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KEYS TO THE FRESHWATER AND ANADROMOUS FISHES OF CALIFORNIA[1]

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Washington, D.C.

LEONARD O. FISK
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The need for keys to all the freshwater and anadromous fishes of California long has been apparent to both scientific workers and laymen. Although numerous keys to California fishes have been published, they have been either restricted to certain drainages (i.e., Miller, 1952; Murphy, 1941; Rutter, 1908) or to groups of fishes (i.e., Beland, 1953; Curtis, 1949; Neale, 1931; Robins and Miller, 1957; Shapovalov, 1947).

The first check list of the freshwater and anadromous fishes of California (Shapovalov and Dill, 1950) listed 101 full species, of which 65 were native species and 26 introduced species. The second check list (Shapovalov, Dill, and Cordone, 1959), issued nine years later, contains 11 species and 7 subspecies not listed in 1950. Six species and one subspecies resulted from introductions into fresh water. Two freshwater and three euryhaline species, and three euryhaline subspecies were added by new collecting or more complete examination of old collections. Three subspecies resulted from taxonomic revisions.

The rate of addition to our fish fauna is somewhat less than that to our avian fauna, and it is unlikely that all North American fish species will some day occur in California, as Grinnell (1922) postulated for birds. It is apparent, however, that the Californian fish fauna is losing its unique character at an accelerated rate. About 18 successful introductions were made prior to 1900. In the first 50 years of this century, nine additional introductions were made, and seven more have been made in the ten years since 1950. It is evident that these keys will need to be revised at intervals, and that, in the interim between revisions, it will be possible to collect fish that cannot be keyed out with them.

The keys are designed to aid people in knowing what California freshwater or euryhaline fish they have in hand. There is no intention to satisfy the needs of the professional taxonomist, although his work is the stuff from which keys are made. Microscopic examination or complicated statistical comparison is unnecessary. We have tried to limit the use of internal key characters to pharyngeal teeth and pyloric caeca counts. A hand lens will be useful.

Several of the minnow and sucker genera contain subspecies that are difficult to differentiate. In these instances the description is accompanied by the original geographic range. Many native minnows have been

[1] Submitted for publication January 1960.
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widely transported as bait and may now occur well outside their original range. An extreme example of this was the collection in 1954 of a Sacramento hitch, *Lavinia e. exilicauda*, from Ramer Lake, Imperial County, approximately 320 road miles south of its regular range.

ACKNOWLEDGMENTS

We have drawn freely upon others for ideas both from published and unpublished material. The former sources are well covered in the accompanying bibliography.

The keys in their original mimeographed form were widely circulated for testing and criticism. Among those who took advantage of this opportunity for revision and comment were Reeve M. Bailey, John P. Harville, Robert R. Miller, George S. Myers, and Thomas L. Rodgers. In most instances, their suggested changes were made. We do not mean to imply, however, that they are in full agreement with our treatment.

For anatomical terms, counts, and methods of measurements (Figure 1) we have only occasionally departed from Hubbs and Lagler (1958). We have followed Shapovalov, Dill, and Cordone (1959) in common and scientific names.

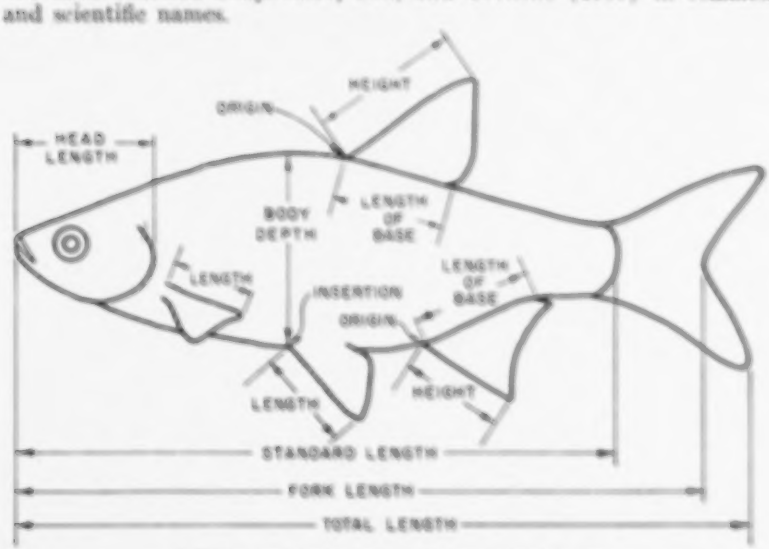

FIGURE 1. Methods of measurements used in the key.

HOW TO USE THE KEYS

These keys are based on alternative characters. For instance, the user finds himself initially confronted with a choice between two characters, 1a and 1b. If the description under 1b fits the fish in hand, he is referred to 2, where a choice between 2a and 2b occurs. This process continues until the fish is identified. At that point a more complete description is given.

Counts and Terms

Technical language has been kept to a minimum. However, a glossary of terms has been included. Figure 2 illustrates a hypothetical bony fish with the more common anatomical terms illustrated.

Scale counts are usually listed in the following manner: 10 to 12—54 to 60—6 or 7. The first figures, 10 to 12, are the number of scale rows above the lateral line. This count is taken from the origin of the dorsal fin downward, following the natural scale row to, but not including, the lateral line scale. The next figures, 54 to 60, represent the number of scales in the lateral series. This is either the number of scales bearing pores in the lateral line or those in the position of a normal lateral line. The scales actually on the base of the caudal fin are not counted. The third set of figures, 6 or 7, represent the scales below the lateral line. The count is made upwards and forward from the origin of the anal fin to, but not including, the scale in the lateral line.

The scale count before the dorsal fin to the occiput is occasionally used. All the scales intercepted by the midline from the origin of the dorsal fin to the edge of the scaleless occiput region are counted.

Gill raker counts indicate the number on the whole first arch on the left side.

In pyloric caeca counts, all tips are included.

Pharyngeal teeth counts are made upon dissection and cleansing of the modified fifth gill arch. A formula 2,5-5,2 means the left pharyngeal bone has 2 teeth in the outer row and 5 in the inner row (2,5); 5 teeth in the inner row and 2 teeth in the outer row of the right side (5,2). A formula 5-4 indicates one row of teeth on each bone, the left bone having 5 teeth and the right 4. Care should be taken that the alveoli or holes where teeth are missing are also included in the count. Individual pharyngeal teeth are frequently shed or lost in cleaning.

Fin rays, when spines occur, are indicated by a combination of Roman and Arabic numerals. The Roman numerals (I, II, III, etc.) represent the number of spines, while the Arabic numerals (1, 2, 3, etc.) represent soft rays. If the spinous rays and soft rays are in the same fin, the numerals are separated by a comma (I, 3).

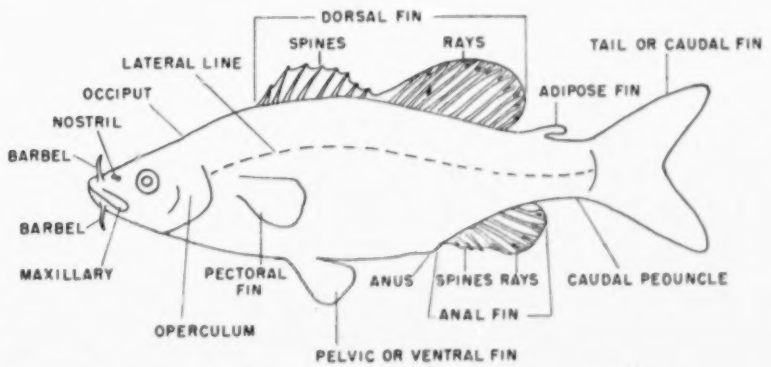

FIGURE 2. Diagram of a hypothetical fish, showing anatomical features used in the key.

KEY TO FAMILIES

1a. Mouth a sucking disc; 7 gill openings on each side of head. Figure 3 ..... PETROMYZONTIDAE—lamprey family, page 463

FIGURE 3. Petromyzontidae

1b. Mouth with true jaws; 4 gill openings covered by operculum 2

2a. Body with 5 rows of large bony shields, each with a large keel or spine; caudal fin lobes unequal. Figure 4 ..... ACIPENSERIDAE—sturgeon family, page 463

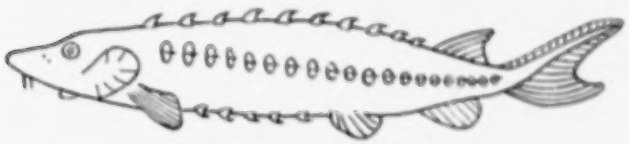

FIGURE 4. Acipenseridae

2b. Body without rows of plates; caudal fin lobes equal or nearly so 3

3a. Body extremely flattened laterally; both eyes on same side of head; coloring on one side of body only. Euryhaline. Figure 5 ..... PLEURONECTIDAE—righteyed flounder family. ..... Starry flounder, *Platichthys stellatus* (Pallas)

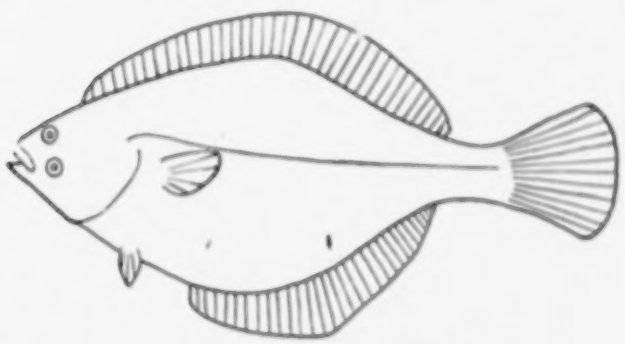

FIGURE 5. Pleuronectidae

3b. Characters not as above 4

4a. Dorsal fin preceded by 3 free spines. Figure 6 ..... GASTEROSTEIDAE—stickleback family. ..... Threespine stickleback, *Gasterosteus aculeatus* Linnaeus

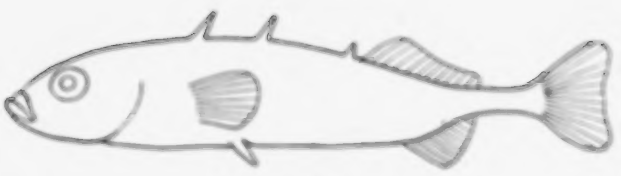

FIGURE 6. Gasterosteidae

4b. Dorsal fin not preceded by free spines, all spines present connected by membranes 5

5a. Gular plate (Figure 27) present between branches of lower jaw. Euryhaline. Figure 7 ..... ELOPIDAE—ladyfish family. ..... Machete; *Elops affinis* Regan

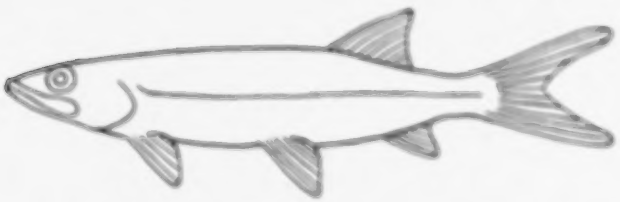

FIGURE 7. Elopidae

5b. Gular plate absent 6

6a. Body without scales 7

6b. Body with scales (one exception in Cyprinidae) 8

7a. Chin with barbels; adipose fin present. Figure 8 .... ICTALURIDAE—catfish family, page 471

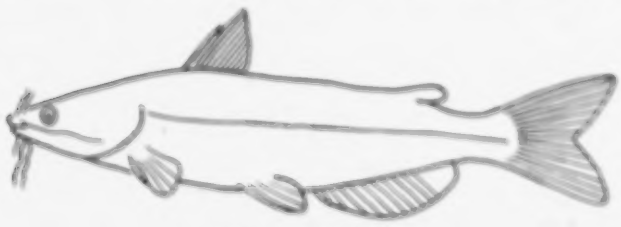

FIGURE 8. Ictaluridae

7b. Chin without barbels; no adipose fin. Figure 9 .... COTTIDAE—sculpin family, page 474

FIGURE 9. Cottidae

8a. Pelvic fins united, forming a sucking disc. Figure 10.....
.....GOBIIDAE—goby family, page 474

FIGURE 10. Gobiidae

8b. No abdominal sucking disc 9

9a. Adipose fin present 10

9b. Adipose fin absent 12

10a. Scales small, more than 100 in lateral series. Figure 11.....
.....SALMONIDAE—salmon and trout family, page 464

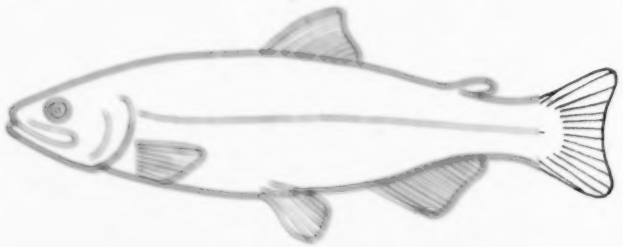

FIGURE 11. Salmonidae

10b. Scales larger, fewer than 100 in lateral series..... 11

11a. Teeth strong; maxillaries extending behind middle of eye; no appendage above base of pelvic fin. Eurybaline. Figure 12.....
.....OSMERIDAE—smelt family, page 464

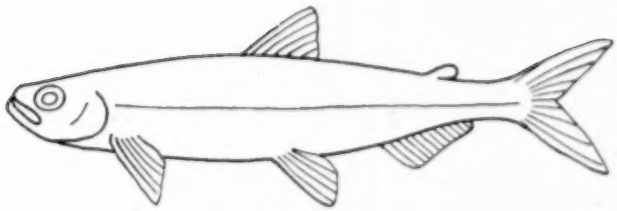

FIGURE 12. Osmeridae

11b. Teeth weak or absent; maxillaries not extending behind middle of eye; scaly appendage above base of pelvic fin. Figure 13 ..... COREGONIDAE—whitefish family
..... Mountain whitefish, *Coregonus williamsoni*, Girard

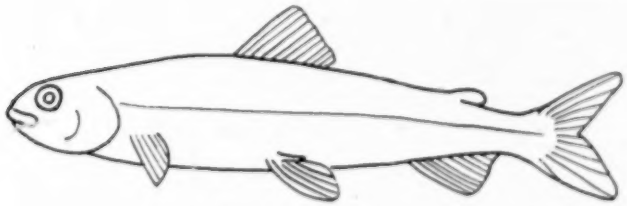

FIGURE 13. Coregonidae

12a. Belly with strong, spiny scutes, like a saw edge. Figure 14 ..... CLUPEIDAE—herring family, page 464

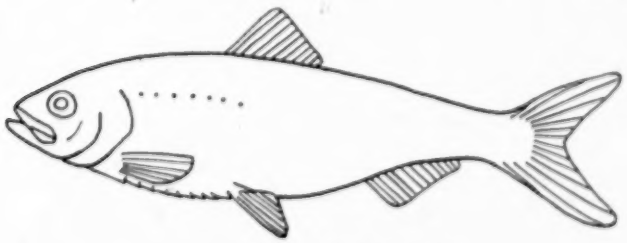

FIGURE 14. Clupeidae

12b. Belly without scutes 13

13a. Caudal fin rounded 14

13b. Caudal fin forked or square, not rounded 16

14a. Dorsal fin with both spines and rays. Colorado River. Euryhaline. Figure 15 ..... ELEOTRIDAE—sleeper family
..... Spotted sleeper, *Eleotris picta*, Kner and Steindachner

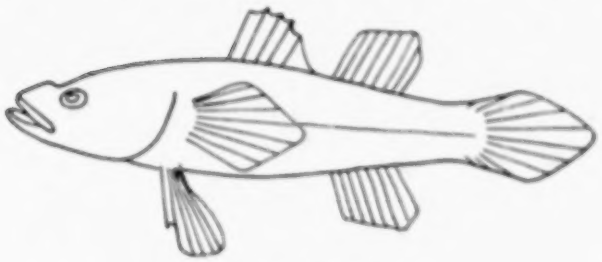

FIGURE 15. Eleotridae

14b. Dorsal fin without spines, composed of rays only

15a. Anal fin of male modified into an intromittent organ; third anal ray unbranched; bear live young. Figure 16.
POECILIIDAE—topminnow family, page 472

FIGURE 16. Poeciliidae

15b. Anal fin of male not modified; third anal ray branched; not livebearers. Figure 17.
CYPRINODONTIDAE—killfish family, page 471

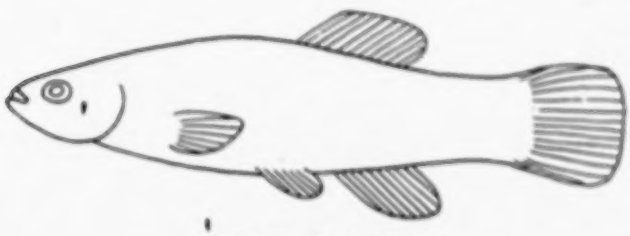

FIGURE 17. Cyprinodontidae

16a. Pelvic fins abdominal 17

16b. Pelvic fins thoracic 19

17a. Dorsal fin separated; stomach gizzard-like; anal spines 3. Euryhaline. Figure 18.
MUGILIDAE—mullet family.
Striped mullet, *Mugil cephalus* Linnaeus

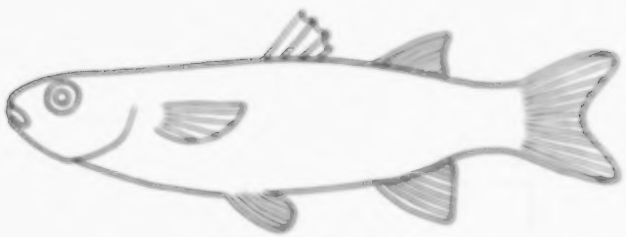

FIGURE 18. *Mugilidae*

17b. Dorsal fin not separated; stomach not gizzard-like; not more than one anal spine..... 18

18a. Mouth fitted for sucking; lips usually thickened and covered with wart-like skin; pharyngeal teath numerous and usually comb-like. Figure 19.
.....CATOSTOMIDAE—sucker family, page 466

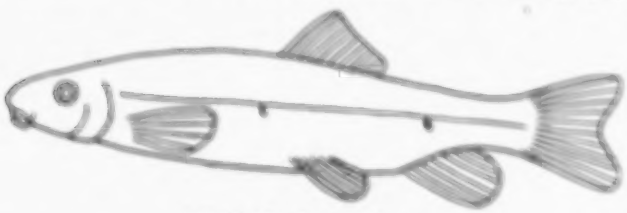

FIGURE 19. *Catostomidae*

18b. Mouth not fitted for sucking; lips thin, never wart-like; pharyngeal teeth fewer than 9 on each side. Figure 20.
.....CYPRINIDAE—carp or minnow family, page 466

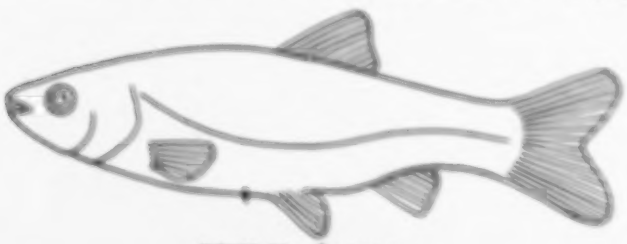

FIGURE 20. *Cyprinidae*

19a. Dorsal fin entirely separated or but slightly joined together..... 20

19b. Dorsal fin united..... 22

20a. Anal spines 3; body with narrow longitudinal stripes. Figure 21.
.....SERRANIDAE—bass family.
.....Striped bass, *Roccus saxatilis* (Walbaum)

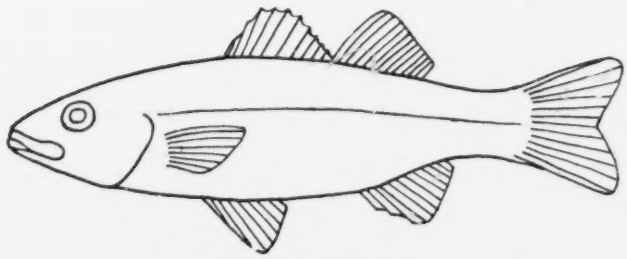

FIGURE 21. Serranidae

20b. Anal spines 1 or 2; body without longitudinal stripes---- 21

21a. Anal spines 2; pelvic fins thoracic. Figure 22.----------
----------PERCIDAE—perch family, page 472

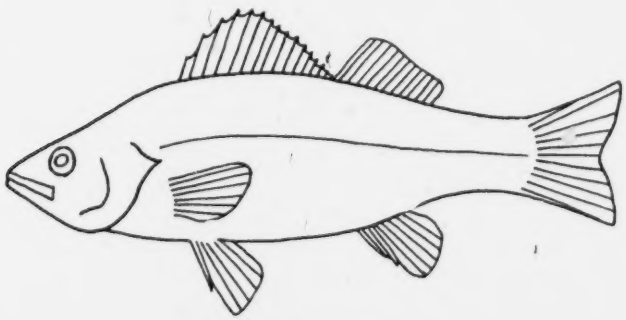

FIGURE 22. Percidae

21b. Anal spine 1; pelvic fins abdominal. Euryhaline. Figure 23.-----
----------ATHERINIDAE—silverside family.
----------Topsmelt, *Atherinops affinis* (Ayres)

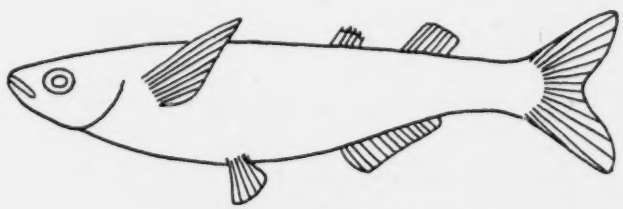

FIGURE 23. Atherinidae

22a. Dorsal fin with distinct ridge of scales along base; bear live young. Figure 24.----------
-----EMBIOTOCIDAE—viviparous perch family, page 474

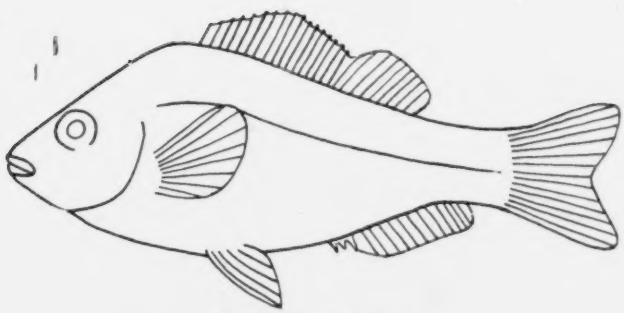

FIGURE 24. Embiotocidae

22b. Dorsal fin without distinct ridge of scales along base; not live-bearers. Figure 25.
---------- CENTRARCHIDAE—sunfish family, page 472

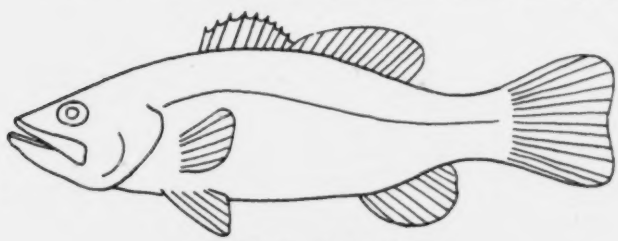

FIGURE 25. Centrarchidae

KEYS TO SPECIES

Family PETROMYZONTIDAE

1a. A posterior series of small teeth present parallel to the marginal series and connecting the last pair of enlarged laterals; usually 4 enlarged laterals
--------- Pacific lamprey, *Entosphenus tridentatus* (Richardson)

1b. No teeth other than the marginals on the posterior field of the disc; 3 enlarged laterals ---------- 2

2a. Dorsal fins usually well separated by an interspace; all teeth sharp and strong; parasitic
---------- River lamprey, *Lampetra ayresii* (Günther)

2b. Dorsal fins separated only by a notch to base; all teeth weak and blunt; nonparasitic
---------- Brook lamprey, *Lampetra planeri* (Bloch)

Family ACIPENSERIDAE

1a. Dorsal rays 44 to 53; anal rays 28 to 32; 4 barbels in a transverse row nearer the tip of snout than the mouth; 38 to 48 bony shields in lateral series on each side of the body; gill rakers 23 to 30
---------- White sturgeon, *Acipenser transmontanus* Richardson

1b. Dorsal rays 33 to 40; anal rays 21 to 31; 4 barbels in a transverse row nearer the mouth than the tip of the snout; 23 to 31 bony shields in lateral series on each side of the body; gill rakers 15 to 19 ---------- Green sturgeon, *Acipenser medirostris* Ayres

Family CLUPEIDAE

1a. Dorsal fin with last ray greatly elongated; stomach gizzard-like; one dark spot behind opercle. Introduced ----------
---------- Threadfin shad, *Dorosoma petenense* (Günther)

1b. Dorsal fin without long ray; stomach muscular but not gizzard-like ---------- 2

2a. Several dark spots behind opercle; head length much less than body depth. Introduced ----------
---------- American shad, *Alosa sapidissima* (Wilson)

2b. No dark spots behind opercle; head length not notably less body depth. Euryhaline ----------
---------- Pacific herring, *Clupea pallasii* Valenciennes

Family OSMERIDAE

1a. Pelvic fins inserted under or behind middle of dorsal; mouth small, maxillary not reaching beyond middle of pupil; pectoral fins small ---------- 2

1b. Pelvic fins inserted in front of middle of dorsal; mouth large, maxillary reaching posterior edge of pupil; pectoral fins large--- 3

2a. Scales 66 to 76 in lateral series; pectoral fins scarcely reaching half way to pelvics. Euryhaline----------
---------- Surf smelt, *Hypomesus pretiosus* (Girard)

2b. Scales 56 to 60 in lateral series; pectoral fins reaching two-thirds distance to pelvics. Euryhaline----------
---------- Pond smelt, *Hypomesus olidus* (Pallas)

3a. Canine teeth present on vomer (Figure 31); scales firmly attached; pectoral fins not reaching insertion of pelvics. Klamath River northward. Euryhaline----------
---------- Eulachon, *Thaleichthys pacificus* (Richardson)

3b. No canine teeth on vomer; scales loosely attached; pectoral fins large, reaching insertion of pelvics. Euryhaline----------
---------- Sacramento smelt, *Spirinchus thaleichthys* (Ayres)

Family SALMONIDAE

1a. Anal fin elongate, 13 to 19 rays (rarely 12); gill rakers 19 to 40 on first arch (Figure 30); branchiostegals 12 to 19; mouth blackish in adults---------- 2

1b. Anal fin short, 9 to 12 rays (rarely 13); gill rakers 20 or fewer on first arch; branchiostegals 10 to 12; mouth whitish in adults- 6

2a. Scales very small, 170 to 232 in lateral series; parr marks absent in young----------
---------- Pink salmon, *Oncorhynchus gorbuscha* (Walbaum)

2b. Scales larger, less than 160 in lateral series 3

3a. Gill rakers long, 30 to 50; parr marks in young small, often oval or rounded, largely above lateral line.....Sockeye salmon (anadromous form); Kokanee salmon (freshwater form), *Oncorhynchus nerka* (Walbaum)

3b. Gill rakers short, 20 to 28 4

4a. Scales usually 19 to 26 above, and usually 15 to 24 below the lateral line; parr marks faint, not rounded, mostly above lateral line.....Chum salmon, *Oncorhynchus keta* (Walbaum)

4b. Scales usually 25 to 31 above, and usually 23 to 34 below the lateral line; parr marks in young extending below lateral line 5

5a. Anal rays usually 15 to 17; pyloric caeca 140 to 150; entire mouth black in adults; young with parr marks wider than interspaces.....King salmon, *Oncorhynchus tshawytscha* (Walbaum)

5b. Anal rays usually 12 to 15; pyloric caeca 50 to 83; gums whitish; young with parr marks narrower than interspaces.....Silver salmon, *Oncorhynchus kisutch* (Walbaum)

6a. Less than 190 scales in lateral series; dark spots on lighter background; vomer (Figure 31) flattened, with teeth on shaft 7

6b. More than 190 scales in lateral series; red or gray spotted on darker background; vomer trough-like, with a toothless shaft 10

7a. Body with distinct parr marks throughout life in stream forms (lake forms lose parr marks at end of first year); a yellowish-orange band on lateral line grading into yellow farther down and finally orange on the abdomen; young lake forms (under 10 inches) not possessing parr marks, having instead of typical golden trout color a rather diffuse rosy tinge on a silvery background.....Golden trout, *Salmo aguabonita* Jordan

7b. Characters not as above 8

8a. Caudal fin not spotted; a few red or brown spots on sides; back covered with brown spots; color on back and sides yellowish or greenish brown. Introduced.....Brown trout, *Salmo trutta* Linnaeus

8b. Body often profusely spotted with black; no red or brown spots on sides; back and sides darker; caudal fin covered with spots 9

9a. Red dash usually along inner edge of dentary bone; small teeth present on basibranchial plate.....Cutthroat trout, *Salmo clarkii* Richardson

9b. No red dash; no teeth on basibranchial plate; a rosy lateral band usually present.....Rainbow trout, *Salmo gairdnerii* Richardson

10a. Caudal fin rather strongly forked; vomer with a raised crest armed with strong teeth; pyloric caeca 95 to 170; no bright spots. Introduced.
Lake trout, *Salvelinus namaycush* (Walbaum)

10b. Caudal fin little forked; vomer without crest, the teeth being confined to the head of the bone; pyloric caeca 20 to 46; red or orange spots on sides. 11

11a. Back unspotted but strongly mottled with olive and black; caudal and dorsal fins marbled. Introduced.
Eastern brook trout, *Salvelinus fontinalis* (Mitchill)

11b. Back not mottled but with light spots like those on sides of body, only paler; caudal and dorsal fins not marbled.
Dolly Varden trout, *Salvelinus malma* (Walbaum)

Family CATOSTOMIDAE

1a. Mouth terminal, oblique; lips thin, without papillae 2

1b. Mouth inferior; lips thick, with papillae 4

2a. Gill rakers short, without tufts on edges and shaped like the Greek letter Delta Δ; snout with pronounced hump.
Lost River sucker, *Deltistes luxatus* (Cope)

2b. Gill rakers long, may be acutely triangular but unlike Greek letter Delta; no hump on snout. 3

3a. Dorsal fin elongate, more than 25 rays. Introduced.
Bigmouth buffalo, *Ictiobus cyprinella* (Valenciennes)

3b. Dorsal fin short, fewer than 20 rays; gill rakers with edges densely tufted. Shortnose sucker, *Chasmistes brevirostris* Cope

4a. Pronounced sharp-edged hump in adults anterior to dorsal fin; median cleft of lower lip deep, separating halves completely. Colorado River.
Humpback sucker, *Xyrauchen texanus* (Abbott)

4b. No sharp-edged hump anterior to dorsal fin. 5

5a. Both jaws with broad, flattened, horny, cutting edges; deep V indentations at junctions of upper and lower lips, median indentation of lower lip not reaching the margin of the lower jaw (Figure 26A). 6

FIGURE 26. Characteristic shape of sucker mouths. A, *Pantosteus;* B, *Catostomus.*

5b. No well-developed cutting edge on either jaw; lower lip evenly joined to upper, no indentations or only slight ones at lateral junctions of lips, median indentation of lower lip reaching margin of jaw or nearly so (Figure 26B). 7

6a. Closed fontanelle; scales in lateral series 74 to 80. Santa Ana River and other southern California waters draining into the Pacific Ocean.
---Santa Ana mountain-sucker, *Pantosteus santaanae* Snyder

6b. Open fontanelle; scales in lateral series 84 to 95. Lahontan drainage and North Fork Feather River.
------Lahontan mountain-sucker, *Pantosteus lahontan* Rutter

7a. More than 80 scales in lateral series. 8

7b. Less than 80 scales in lateral series. 11

8a. Lower lip not deeply incised, so that two or more rows of papillae extend across the symphysis. Klamath River drainage.
Klamath smallscale sucker, *Catostomus rimiculus* Gilbert and Snyder

8b. Lower lip deeply incised, so that not more than one row of papillae extends across the symphysis. 9

9a. Body slender, fusiform, with an especially slender caudal peduncle; free margin of dorsal fin concave; unusually large lower lip divided to base. Colorado River, rare.
---Flannelmouth sucker, *Catostomus latipinnis* Baird and Girard

9b. Body heavier, not fusiform, caudal peduncle moderately thick; one row of papillae extending across symphysis. 10

10a. Fontanelle closed or at most represented by a narrow slit in specimens 6 inches long or over. Pit River drainage.
----------Modoc sucker, *Catostomus microps* Rutter

10b. Fontanelle present throughout life. Lahontan drainage, introduced into parts of the Sacramento River system, such as the upper Feather River and the Rubicon River.
--------Tahoe sucker, *Catostomus tahoensis* Gill and Jordan

11a. Species of the Klamath River drainage; scales 13 or 14—69 to 77—10 or 11, scales before dorsal fin about 32; caudal peduncle deep; not common.
----------Klamath largescale sucker, *Catostomus snyderi* Gilbert

11b. Species of the Russian River and the Sacramento-San Joaquin drainage. Scales 13 to 17—62 to 72—10 to 12, scales before dorsal 31 to 38; pectoral fins pointed.----------Sacramento western sucker, *Catostomus occidentalis occidentalis* Ayres

11c. Species of the Goose Lake, Modoc County, drainage; scales 13 to 17—62 to 75—8 to 10, scales before dorsal fin 29 to 36.---Goose Lake western sucker, *Catostomus occidentalis lacusanserinus* Fowler

11d. Species of the Eel River, Bear River (Humboldt County), and Mad River; scales 11 to 14 – 62 to 69 – 8 to 10, scales before dorsal fin 27 to 34; pectoral fins rounded; mouth larger than *C. o. occidentalis*-----Humboldt sucker, *Catostomus humboldtianus* Snyder

11e. Species of streams tributary to Monterey Bay; scales 10 to 13 – 57 to 63 – 8 to 10, scales before dorsal fin 23 to 31
----------Monterey sucker, *Catostomus mniotiltus* Snyder

Family CYPRINIDAE

1a. Dorsal fin with 1 or 2 spines 2

1b. Dorsal fin without spines 4

2a. First two dorsal rays modified as smooth spines, the anterior with a groove on the posterior side into which the second fits; no scales ..... Woundfin, *Plagopterus argentissimus* Cope

2b. Only first dorsal ray modified as a strong serrate spine 3

3a. Upper jaw with 2 barbels on each side. Introduced ..... Carp, *Cyprinus carpio* Linnaeus

3b. Upper jaw without barbels. Introduced ..... Goldfish, *Carassius auratus* (Linnaeus)

4a. A fleshy scaleless keel on abdomen between pelvic and anal fins. Introduced ..... Golden shiner, *Notemigonus crysoleucas* (Mitchill)

4b. No fleshy keel on fully-scaled abdomen 5

5a. Scales in lateral series 100 or more 6

5b. Scales in lateral series 90 or less 7

6a. Upper jaw with one barbel on each side. Introduced ..... Tench, *Tinca tinca* (Linnaeus)

6b. Upper jaw without barbels ..... Sacramento blackfish, *Orthodon microlepidotus* (Ayres)

7a. Anal rays usually 10 to 14, dorsal rays 10 to 13; body laterally compressed ..... Hitch, *Lavinia exilicauda* Baird and Girard 8

7b. Anal rays usually 6 to 9 (rarely 10) 9

8a. Species of the Pajaro and Salinas River drainages; scales 12 to 14–54 to 60–6 or 7, scales before dorsal fin 31 to 35; dorsal fin rays 10 (8 to 12), anal fin rays 10 (8 to 13) ..... Monterey hitch, *Lavinia exilicauda harengus* Girard

8b. Species of the Sacramento-San Joaquin River drainage and the Russian River; scales 12 to 14–57 to 62–6 or 7, scales before dorsal fin 35 to 38; dorsal fin rays 11 (10 to 12), anal fin rays 13 (11 to 14) ..... Sacramento hitch, *Lavinia exilicauda exilicauda* Baird and Girard

9a. Premaxillaries bound to snout by a frenum (Figure 29) ..... Hardhead, *Mylopharodon conocephalus* (Baird and Girard)

9b. No frenum, premaxillaries protractile, separated from snout by a groove 10

10a. Upper jaw barbel well developed; upper lobe of caudal fin considerably longer than lower ..... Splittail, *Pogonichthys macrolepidotus* (Ayres)

10b. Upper jaw barbel absent; upper and lower lobes of caudal fin approximately equal 11

11a. Less than 45 scales in lateral series 12

11b. More than 45 scales in lateral series 13

12a. Lateral line incomplete; adults with horizontal dark bar across dorsal fin; scales crowded before dorsal fin. Introduced ..... Fathead minnow, *Pimephales promelas* Rafinesque

12b. Lateral line complete; dorsal fin without dark bar; scales not crowded before dorsal fin. Introduced ..... Red shiner, *Notropis lutrensis* (Baird and Girard)

13a. Body slender, pike-like; snout long and pointed 14

13b. Body not pike-like; snout shorter 15

14a. Anal fin rays 9. Colorado river drainage ..... Colorado River squawfish, *Ptychocheilus lucius* Girard

14b. Anal fin rays 7 or 8. Sacramento-San Joaquin and Russian River drainages and tributaries of San Francisco and Monterey bays ..... Sacramento squawfish, *Ptychocheilus grandis* (Ayres)

15a. Pharyngeal teeth in two rows 16

15b. Pharyngeal teeth in one row 22

16a. Mouth inferior; barbel on upper jaw; radii present on all fields of the scale 17
Speckled dace; *Rhinichthys osculus* (Girard)

16b. Mouth terminal; no barbel on upper jaw; radii present only on the apical and/or lateral fields of the scale 18

17a. Species of the Lahontan drainage; scales 12 to 14—56 to 77—9 to 11 ..... Lahontan speckled dace, *Rhinichthys osculus robustus* (Rutter)

17b. Species of the Sacramento-San Joaquin River drainage and most Pacific Ocean drainages in California; scales in lateral series 49 to 77 ..... Pacific speckled dace, *Rhinichthys osculus carringtonii* (Cope)

17c. Species of the Klamath River drainage; scales in lateral series 60 to 81 ..... Klamath speckled dace, *Rhinichthys osculus klamathensis* (Evermann and Meek)

17d. Species of the Death Valley drainage in California; scales in lateral series about 65 ..... Nevada speckled dace, *Rhinichthys osculus nevadensis* Gilbert

18a. Scales crowded before dorsal; dark lateral band between two lighter bands ..... Lahontan redside, *Richardsonius egregius* (Girard)

18b. Scales not crowded before dorsal; coloration not as above 19

19a. Origin of dorsal fin slightly behind origin of pelvic fins 20

19b. Origin of dorsal fin above origin of pelvic fins 21

20a. Caudal peduncle extremely slender; dorsal fin rays 10 or 11, anal fin rays 9 to 11; scales in lateral series 75 to 85. Colorado River drainage ..... Bonytail chub, *Gila robusta* Baird and Girard

20b. Caudal peduncle moderately thick; dorsal fin rays 8 (7 to 9), anal fin rays 7; scales in lateral series 52 to 63. Southern California streams tributary to the Pacific; may be introduced elsewhere ---
---Arroyo chub, *Gila orcuttii* (Eigenmann and Eigenmann)

21a. Dorsal fin rays 8, anal fin rays 7 to 9; scales in lateral series 60 to 70; caudal peduncle moderately thick. Klamath River drainage
---Klamath chub, *Gila bicolor* (Girard)

21b. Dorsal fin rays 8, anal fin rays 8; scales in lateral series 50 to 56; caudal peduncle nearly as deep as long; caudal fin only slightly broader than caudal peduncle. Sacramento-San Joaquin River drainage ---
---Thicktail chub, *Gila crassicauda* (Baird and Girard)

22a. Origin of dorsal fin over or before insertion of pelvics; scales before dorsal fin 23 to 33 ---
---Tui chubs, *Siphateles* 23

22b. Origin of dorsal fin behind insertion of pelvics; scales before dorsal fin 32 to 38 ---- 24

23a. Species of the Klamath River drainage; scales 10 to 12—43 to 54—5 to 7, scales before dorsal fin 22 to 27; anal fin rays 7 or 8 ---
---Klamath tui chub, *Siphateles bicolor bicolor* (Girard)

23b. Species of the Sacramento-San Joaquin River drainage; scales 10 to 13—44 to 54—5 to 7, scales before dorsal fin 22 to 28; anal fin rays 7 to 9, dorsal fin rays 9; gill rakers on first arch 13 to 20
---Sacramento tui chub, *Siphateles bicolor formosus* (Girard)

23c. Species of the Lahontan drainage; scales 12 to 16—50 to 60—7 or 8, scales before dorsal fin 27 to 33; anal fin rays 7 or 8, dorsal fin rays 8; gill rakers on first arch 8 to 20 ---
---Coarseraker tui chub, *Siphateles bicolor obesus* (Girard)

23d. Species of the Lahontan drainage; scales 13 to 15—57 to 63—7 or 8, scales before dorsal fin 29 to 33; anal fin rays 8, dorsal fin rays 8; gill rakers on first arch 29 to 36 ---
---Fineraker tui chub, *Siphateles bicolor pectinifer* (Snyder)

23e. Species of the Mojave River drainage; scales 11 to 13—46 to 55—7 or 8, scales before dorsal fin 23 to 30; anal fin rays 7 or 8, dorsal fin rays 8 to 10; gill rakers on first arch 18 to 29 ---
---Mojave chub, *Siphateles mohavensis* Snyder

24a. Species of the Sacramento-San Joaquin River drainage; scales 12 or 13—47 to 57—6 to 8, scales before dorsal fin 30; anal fin rays 8 or 9, dorsal fin rays 8 to 10; gill rakers on first arch 8 to 10, short, blunt ---
---Sacramento western roach, *Hesperoleucus symmetricus symmetricus* (Baird and Girard)

24b. Species of streams tributary to Monterey Bay; scales 12 to 16—51 to 57—7 or 8, scales before dorsal 27 to 32; anal fin rays 7 or 8, dorsal fin rays 7 or 8; gill rakers on first arch 9, short, blunt ---Monterey western roach, *Hesperoleucus symmetricus subditus* Snyder

24c. Species of streams tributary to Goose Lake, Modoc County; scales 12 to 15—54 to 61—8, scales before dorsal 32 to 38; anal fin rays 7, dorsal fin rays 8; gill rakers on first arch 8 or 9, short, blunt; peritoneum black to dusky ..... Northern roach, *Hesperoleucus mitrulus* Snyder

24d. Species of the Russian River and streams tributary to San Francisco Bay; scales 13—50 to 63—7, scales before dorsal fin 30, anal fin rays 8, dorsal fin rays 9; gill rakers on first arch 10, short, pointed, widely spaced. The eye is smaller and the head shorter than the other species; ventral fins rounded, not reaching anal ..... Venus roach, *Hesperoleucus venustus* Snyder

24e. Species of the Navarro River system, Mendocino County; scales 11 to 14—51 to 59—7, scales before dorsal fin 30; anal fin rays 8, dorsal fin rays 8; gill rakers on first arch 8, very short, blunt; tips of ventrals reach anus ..... Navarro roach, *Hesperoleucus navarroensis* Snyder

24f. Species of the Gualala River system, Sonoma County; scales 14 to 16—54 to 59—7 or 8, scales before dorsal fin 32; anal fin rays 7 or 8, dorsal fin rays 8; gill rakers on first arch 8, very short, blunt; ventrals reach anus when depressed, edges rounded ..... Gualala roach, *Hesperoleucus parvipinnis* Snyder

FAMILY ICTALURIDAE

1a. Caudal fin forked 2

1b. Caudal fin square or rounded 3

2a. Anal fin short, 19 to 23 rays; no dark spots present on sides. Introduced ..... White catfish, *Ictalurus catus* (Linnaeus)

2b. Anal fin long, 24 to 29 rays; dark spots often present on sides, especially in juveniles and nonbreeding adults. Introduced ..... Channel catfish, *Ictalurus punctatus* Rafinesque

3a. Anal rays 24 to 27; caudal fin rounded; chin barbels whitish. Introduced ..... Yellow bullhead, *Ictalurus natalis* (LeSueur)

3b. Anal rays 17 to 24; caudal fin square-cut; chin barbels gray to black 4

4a. Pectoral spines with strong barbs on posterior edge; fin rays and membranes of same color; gill rakers 11 to 14 on first arch. Introduced ..... Brown bullhead, *Ictalurus nebulosus* (LeSueur)

4b. Pectoral spines with weak barbs; fins generally with jet black membranes; gill rakers 16 to 18 on first arch. Introduced ..... Black bullhead, *Ictalurus melas* (Rafinesque)

Family CYPRINODONTIDAE

1a. Teeth all pointed, none of them compressed, bicuspid or tricuspid. ..... California Killifish, *Fundulus parvipinnis* Girard

1b. Teeth incisor-like, notched, bicuspid, or tricuspid 2

2a. Pelvic fin rays 7-7; pelvic fins large, always present; dorsal fin equidistant between caudal base and tip of snout 3

2b. Pelvic fin rays 6-6; pelvic fins small, occasionally lacking; dorsal fin nearer caudal base than tip of snout 4

3a. Scale circuli with spine-like projections; interspaces between circuli without conspicuous reticulations; central cusp of tricuspid teeth spatulate .....
.....Desert pupfish, *Cyprinodon macularius* Baird and Girard

3b. Scale circuli without projections; interspaces between circuli densely reticulated; central cusp truncate .....
.....Owens Valley pupfish, *Cyprinodon radiosus* Miller

4a. Scales small, 28 or 29 in lateral series, 39 or 40 around body; outer face of tricuspid teeth with prominent, median ridge ...
.....Salt Creek pupfish, *Cyprinodon salinus* Miller

4b. Scales large, 25 or 26 in lateral series, 24 around body; no median ridge on tricuspid teeth .....Nevada pupfish, *Cyprinodon nevadensis* Eigenmann and Eigenmann

Family POECILIDAE

1a. Origin of dorsal fin well behind that of anal fin; dorsal fin rays 7 to 9. Introduced .....
.....Mosquitofish, *Gambusia affinis* (Baird and Girard)

1b. Origin of dorsal over or before that of anal; dorsal fin rays 13 to 16. Introduced .....Sailfin molly, *Mollienesia latipinna* LeSueur

Family PERCIDAE

1a. Preopercle not strongly serrated; mouth small; body crossed with 9 to 15 primary bands, with shorter secondary bars alternating. Introduced .....Log perch, *Percina caprodes* (Rafinesque)

1b. Preopercle strongly serrated; mouth large 2

2a. No canine teeth; body crossed with 6 to 8 strong vertical bands; anal fin with 6 to 8 soft rays. Introduced .....
.....Yellow perch, *Perca flavescens* (Mitchill)

2b. Strong canine teeth; body may be blotched but not crossed by vertical bars; anal fin with 12 to 16 soft rays. Introduced.
.....Walleye, *Stizostedion vitreum* (Mitchill)

Family CENTRARCHIDAE

1a. Anal spines 5 or more; branchiostegal rays 7 2

1b. Anal spines 3; branchiostegal rays 6 4

2a. Dorsal fin spines 12 or 13; dorsal fin base about twice length of anal fin base .....
.....Sacramento perch, *Archoplites interruptus* (Girard)

2b. Dorsal fin spines 5 to 9; dorsal fin base about equal to anal fin base 3

3a. Dorsal fin spines normally 7 or 8; length of dorsal fin base about equal to distance from origin of dorsal fin to eye; body with dark mottling. Introduced. ---------- Black crappie, *Pomoxis nigromaculatus* (LeSueur)

3b. Dorsal fin spines normally 6; length of dorsal fin base much less than distance from origin of dorsal fin to eye; body more definitely banded. Introduced. White crappie, *Pomoxis annularis* Rafinesque

4a. Scales small, 58 or more in lateral series; body depth about one-third standard length. ---------- 5

4b. Scales large, 53 or fewer in lateral series; body depth about one-half standard length. ---------- 7

5a. Dorsal fin almost divided; anal and soft dorsal fin with no scales on membrane near base; mouth large, upper jaw extending beyond eye in adults; sides of young and small adults with dark, rather even lateral band. Introduced. ---------- Largemouth bass, *Micropterus salmoides* (Lacépède)

5b. Dorsal fin not deeply notched; anal fin and soft dorsal fin with scales on membrane near base; mouth moderate, upper jaw not extending beyond eye in adults; lateral band, if present, always broken. ---------- 6

6a. Predorsal contour generally flat; scales in lateral series 60 to 68; broken lateral band of blotches always present. Introduced. ---------- Spotted bass, *Micropterus punctulatus* (Rafinesque)

6b. Predorsal contour rounded; scales in lateral series 69 to 80; sides of young and small adults with vertical bars or broad blotches with light centers, lacking in adults. Introduced. ---------- Smallmouth bass, *Micropterus dolomieui* Lacépède

7a. Teeth present on tongue. Introduced. ---------- Warmouth, *Chaenobryttus gulosus* (Cuvier)

7b. No teeth on tongue. ---------- 8

8a. Upper jaw extending to middle of eye; pectoral fin short and rounded, contained about four times in standard length. Introduced. ---------- Green sunfish, *Lepomis cyanellus* Rafinesque

8b. Upper jaw not extending nearly to middle of eye; pectoral fins long and pointed, contained about three times in standard length. ---------- 9

9a. Opercular bone flexible posteriorly; gill rakers long and slender. Introduced. ---------- Bluegill, *Lepomis macrochirus* Rafinesque

9b. Opercular bone stiff behind; gill rakers short and stout. ---------- 10

10a. Opercle with definite scarlet spot; cheeks with prominent blue and orange stripes in life; pectoral fins less than one-third standard length in adult. Introduced. ---------- Pumpkinseed, *Lepomis gibbosus* (Linnaeus)

10b. Opercle with broad scarlet margins; cheeks without conspicuous orange and blue streaks; pectoral fins more than one-third standard length in adult. Introduced. ---------- Red-ear sunfish, *Lepomis microlophus* (Günther)

Family EMBIOTOCIDAE

1a. Dorsal spines 10 or less. Euryhaline
Shiner perch, *Cymatogaster aggregata* Gibbons

1b. Dorsal spines 15 or more. Freshwater
Tule perch, *Hysterocarpus traskii* Gibbons

Family COTTIDAE

1a. Upper preopercular spine antler-like, long, with recurved barbs along its upper margin. Euryhaline
Staghorn sculpin, *Leptocottus armatus* Girard

1b. All peropercular spines small, simple, inconspicuous 2

2a. Palatine teeth absent 3

2b. Palatine teeth present 4

3a. Lateral line complete or nearly so; pelvic fins long, when depressed reach anus
Aleutian sculpin, *Cottus aleuticus* Gilbert

3b. Laterial line very incomplete; pelvic fins shorter. Klamath River
Klamath sculpin, *Cottus klamathensis* Gilbert

4a. Pelvic rays I, 3 5

4b. Pelvic rays I, 4 (spine may be embedded in first ray) 6

5a. Area between dorsal fins and lateral line entirely naked or with only minute prickles. Euryhaline
Sharpnose sculpin, *Clinocottus acuticeps* (Gilbert)

5b. Area from pectoral fin to a point under the second dorsal covered with prickles
Rough sculpin, *Cottus asperrimus* Rutter

6a. Skin entirely smooth
Piute sculpin, *Cottus beldingii* Eigenmann and Eigenmann

6b. Skin with prickles 7

7a. Skin entirely covered with prickles; vent midway between base of caudal fin and tip of snout; dorsal rays 17 to 20; caudal veterbrae 24 to 27
Prickly sculpin, *Cottus asper* Richardson

7b. Skin with prickles restricted to region behind pectorals; vent nearer base of caudal fin than tip of snout; dorsal rays 16 to 18; caudal vertebrae 21 to 24
Riffle sculpin, *Cottus gulosus* (Girard)

Family GOBIIDAE

1a. Maxillaries normal; skull short and abruptly broadened behind orbits. Euryhaline
Tidewater goby, *Eucyclogobius newberryi* (Girard)

1b. Maxillaries extended backward, to beyond the gill opening in adult; skull comparatively long and gradually (not abruptly) broadened behind orbits 2

2a. Occiput depressed, with a blunt median keel; dorsal fin VI, 12 or 13; anal fin 10 or 11. Euryhaline
.....Longjaw mudsucker, *Gillichthys mirabilis* Cooper

2b. Occiput transversely rounded without median keel; dorsal fin IV or V, 14 to 17; anal fin 16 or 17. Euryhaline
.....Arrow goby, *Clevelandia ios* (Jordon and Gilbert)

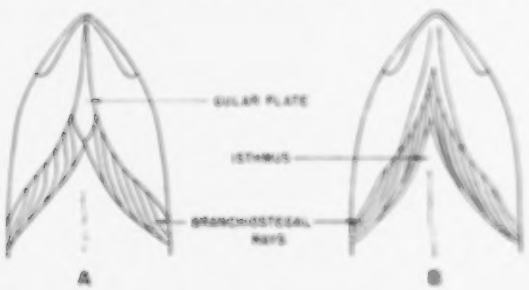

FIGURE 27. Diagram of the underside of the head of a fish. A, with a gular plate; B, without a gular plate.

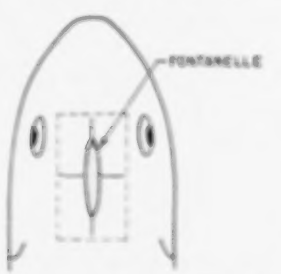

FIGURE 28. Diagram of the top of the head of a fish showing the position of the fontanelle when present.

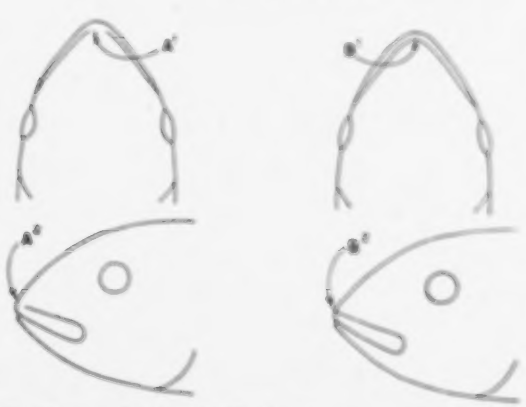

FIGURE 29. Diagram of fish heads. A', A'', with a frenum; B', B'', without a frenum.

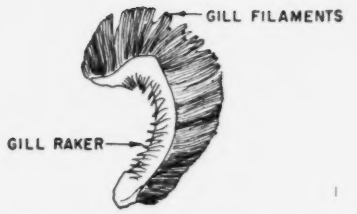

FIGURE 30. First gill arch taken from the left side showing gill rakers and gill filaments.

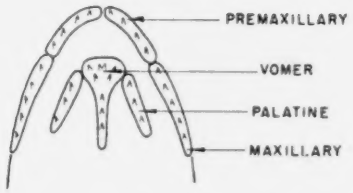

FIGURE 31. Diagram illustrating the tooth-bearing bones on the upper jaw and in the roof of the mouth.

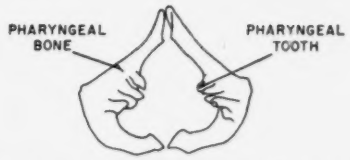

FIGURE 32. Diagram of the pharyngeal bones of a minnow.

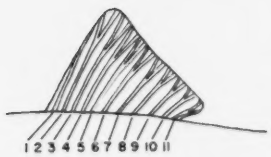

FIGURE 33. Diagram illustrating a soft-rayed fin and the method of counting rays.

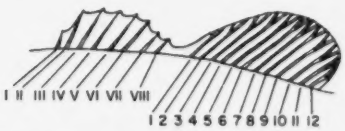

FIGURE 34. Diagram of the dorsal fin of a fish with both spines and soft rays illustrating method of counting. The formula in this instance would be VIII, 12.

GLOSSARY

Abdominal—Refers to the belly. Abdominal fins are also called ventral fins or pelvic fins. Figure 2.

Abdominal sucking disc—The pelvic fins united to form a flaring cone free from the body.

Adipose fin—The small, fleshy fin on the back, between the dorsal and caudal fin in some groups of fish. Figure 2.

Air bladder—A sac filled with gas, lying beneath the backbone and above the digestive tract.

Anal fin—The single fin on the median abdominal line behind the vent. Figure 2.

Apical—The posterior or exposed margin of a scale.

Basibranchial plate—The median bony structure (or rod or plate) on the floor of the throat.

Bicuspid—Top of tooth with two projections.

Branchiostegal rays—The bony rays supporting the gill membranes, under the lower jaw and between the lower portions of the opercular bones. Figure 27.

Barbel—A fleshy threadlike or conical projection usually about the mouth. The "whiskers" of catfish are barbels. Figure 2.

Caudal fin—The tail fin. Figure 2.

Caudal peduncle—The slender region between the end of the anal fin and the base of the caudal fin. Figure 2.

Compressed—Flattened laterally.

Circuli—Concentric ridges appearing as rings on the scales.

Concave—Hollow and curved or rounded.
Cusp—Apex or top of tooth.
Dentary bone—Anterior bone of the lower jaw.
Dorsal fin—The fin on the median line of the back. May be double. Figure 2.
Euryhaline—Species able to live extended periods in fresh, brackish, or salt water.
Fontanelle—An opening in a body surface. In some fish this refers to the area of cartilage in the mid-dorsal region of the skull. Figure 28.
Frenum—A bridge of tissue binding or restraining the apex of the upper jaw to the snout. Figure 29.
Fusiform—Spindle-shaped.
Gill arch—The bony arch to which the gills are attached. Figure 30.
Gill rakers—Slender, spine-like structures attached to the gill arches. Figure 30.
Gular plate—A large median dermal bone lying in the throat region. Figure 27.
Hypural plate—The expanded last vertebrae.
Incisor—A tooth adapted for cutting. Chisel-like rather than pointed.
Inferior mouth—Mouth on the under side of the head.
Insertion—The position at which a paired fin is joined to the body. Figure 1.
Intromittent organ—Copulatory organ; i.e., modified anal fin of poeciliid male.
Lateral line—A series of tubes and pores along the sides of a fish's body opening into sensory organs located beneath the scales. Figure 2.
Maxillaries—The bones of the upper jaw. The first bone on either side of the midline of the upper jaw is the premaxillary. The second bone is the maxillary. Figure 2.
Median—Situated on the midline of the fish; i.e., either the center of the back or center of the belly.
Oblique—Slanting, inclined; not horizontal.
Occiput—The back of the head; usually where the scales of the back stop. Figure 2.
Orbit—The eye socket.
Opercular bones—Gill cover bones. Figure 2.
Origin—The anteriormost extremity of the base of an unpaired fin. Figure 1.
Palatine teeth—Teeth on the paired bones of the roof of the mouth, just back of the vomer. Figure 31.
Papillae—Small fleshy protuberances.
Parr mark—Dusky vertical bars found on young trout and salmon.
Pectoral fins—The anterior or uppermost paired fins. Figure 2.
Pelvic fins—The paired fins attached to the pelvic girdle. The lowermost or rear paired fins. Figure 2.
Peritoneum—Interior lining of the body cavity.
Pharyngeal teeth—Teeth on the pharyngeal bones behind the gills in the throat. Figure 32.
Preopercular spine—A spine (or spines) on the cheekbone nearest the eye and next to the largest gill cover bone.
Protractile—Capable of being projected forward.
Pyloric caeca—Finger-like processes attached to the intestine where it leaves the stomach.
Radii—Lines on the scales extending from the center to the edge.
Ray—A supporting rod for a fin. They include segmented soft rays and unsegmented hard or spiny rays.
Reticulations—A series of web-like or network marks.
Scutes—Bony or horny plates.
Serrate—Notched or toothed on edge.
Spatulate—Spoon-shaped.
Spine—The unsegmented supports of the fin membranes, regardless of whether or not they are stiff.
Symphysis—The point where two bones join together in the median plane of the body (i.e., the two halves of the lower jaw at the chin).
Terete—Cylindrical in cross section.
Terminal mouth—Mouth in which neither the upper nor the lower jaw projects.
Thoracic—The chest region.
Tricuspid—Top of tooth with three projections.
Truncate—Square ended.
Ventral—Refers to the belly surface.
Ventral fins—See pelvic fins.
Viviparous—Brings forth the young alive.
Vomer—Middle palate-bone in the roof of the mouth. Figure 31.

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